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A Design and Implementation of SIP-Based Distance Education System

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Abstract

The basic content of the session initiation protocol and its protocol's characteristic are analyzed in the paper, combining the model of distance education system, a distance education system based on SIP protocol is proposed, and then introduces a model of system and gives a brief description of each component of the model, A detailed explanation about the implementation of each model is given.

Key words: SIP ; SIP Server; Class management system; Class control system

1. Introduction

Distance education is an educational form, in which, multiple media will be adopted for the systematic teaching and intercommunication between students and teachers, as well as between students and educational institutions. It is an education form for transmitting course contents to students at one or more than one places outside the campus. As for modern distance education, audios, videos (live or recorded), and real-time or non-real-time computer technology will be used to transmit courseware to locations off the campus . Modern distance education is a new educational mode appeared with the development of modern information technology. The rapid advancement of computer technology, multimedia technology, communication technology, especially the Internet technology has endowed distance education with a qualitative leap, making it become an educational form based on high and new technologies. Distance education will not be restricted by geographical factors. Teaching based on distance education can be launched among teachers and students at the same time, while in different pleases. Moreover, teaching contents, teaching methods, and teaching objects of distance education are highly opened. Such open education system has provided a good condition for the life-long education and life-long learning in this age of knowledge economy. At present, appeals requesting for a balanced development of educational resources are becoming stronger and stronger. Moreover, demands for distance education are increasing as well. In order to real-timely, conveniently and reliably transmit high quality education resources onto

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the far-ends, we'll need to establish a complete and stable distance education system. This is of great importance for both education administration authorities and end-users.

2. Session Initiation Protocol (SIP)

2.1 Natures of the SIP Call Control Technology

SIP (Session Initiation Protocol) was put forward and studied by IETF, and was an application layer controlling protocol for conducting multimedia communication over IP network. SIP was used to create, modify and terminate sessions participated by one or more than attendances. Such sessions can be Internet multimedia meeting, IP telephone, distance education, as well as telemedicine. In other words, all interactive multimedia communication activities participated by two or more parties on the Internet can be regarded as multimedia sessions [1]. Members who are participating in the sessions can communicate via multi-cast method, single-cast method, or the method by combining the two ways together.

SIP would create, control and terminate sessions through request messages (from client to server); obtain the processing result of its requests through response messages (from server to client). SIP messages are comprised by three parts: initial row (request/response), SIP head and message body.

SIP would identify users' addresses with URL address, which can be users' name @ host address, email name @ website address, telephone number @ PSTN gateway address, etc. SIP URL can be easily associated with users' e-mail address or other contact information.

According to concrete operation, address and protocol feature, request-line and header field will define the property of call. The message body is independent from SIP, and is enabled to include any kinds of contents.

SIP has totally formulated six kinds of signaling: INVITE, ACK, CANCEL, OPTIONS, BYE, and REGISTER. INVITE and ACK are designed for creating call sessions to complete the three-way handshake, or to modify the property of the created sessions. BYE is designed to terminate sessions. OPTIONS is used for querying the performance of server. CANCEL is applied to terminate the already-sent but not-finished request sessions. REGISTER is designed for users to register their locations, and other information up to the registration server.

Five types of response state: 1xx: Information; 2xx: Correct; 3xx: Redirection; 4xx: Client Error; 5xx: Server Error.

SIP message header can be classified into four types: universal header, request header, response header, and entity header. The most frequently used header fields include: From, To, Call-ID, CSEQ, Via, Contact, etc. These fields are employed to identify various related parameters in sessions. The optional entity header mainly adopted the complete text form and the SDP session description, and is mainly applied to state the communication ability of the two parties in the session .

2.2 Communication Function and Architecture of SIP

When creating or terminating a multimedia communication session, SIP mainly provides functions in the following aspects:

- User Location: to figure out the client system for communication;
- User Availability: to figure out whether the called party is willing to start the communication;
- User Capability: to figure out media type and media parameters used in the session;
- Session Creation: to create the session between the call party and the called party;
- Session Management: including transferring and terminating a session, modifying session parameters, as well as corresponding invoking operations.

SIP-based system is actually a system between users and servers, in which, defined network elements include: user agent, SIP proxy server, redirect server, and SIP register server [2].

- User Agent (UA) is the client network element in SIP system. In accordance with their behaviors in sessions, they can also be named as User Agent Client (UAC) and User Agent Server (UAS). The former is designed to initiate a call request, while the latter is applied to response to the call request.
- Proxy Sever is an intermediate network element, which is the client, as well as the server. A proxy server can process onto the next SIP server act on behalf of the users of the previous server. It may also send out call request on behalf of the final destination users. Besides, a proxy server can also distribute requests to other several SIP servers.
- Redirect Server is designed for planning the SIP call patch, redirecting users to other SIP servers, and enabling users to take other servers as the next hop to the final destination, as well as to release the request.
- Register Server is design for accepting the logging-in of UAS, so as to record users' current location information.

3. SIP-based Modern Distance Education System

3.1. General System Frame

The system has adopted the client-server mode, while the sever has employed the centerlization and distribution combined hierarchy structure, for the benefit of centralized control and management [3]. The system mainly was mainly realized through four fucntional entities, including SIP server (comprised by SIP Register Server, SIP Proxy Sever, and SIP Redirect Server), classroom management syste, classroom control system and SIP classroom terminal, see Fig 1.

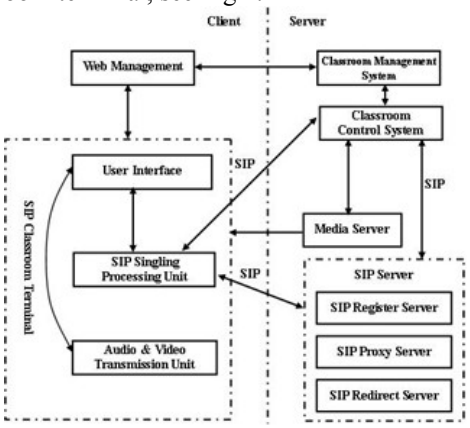

Fig 1, General System Frame of SIP Distance Education System

3.2 Classroom Management System

Classroom management system is the soul of the entire SIP distance education system, which provides management interface in the form of web pages. This module enables administrators to create, modify and delete classrooms. Besides, it may also generate an independent classroom management agent in

accordance with administrator's configurations, so that this classroom management agent can be invited to join in the classroom, as well as to administrate the classroom. Classroom management system can be used to administrate more than on classroom control servers. At the meantime, it also plays a role as the classroom strategy server. In practical usage, classroom management system will provide SIP classroom terminals with dynamic information of the classroom through the classroom web server and in the form of web. Before a teacher starts a class, classroom control server will send related information concerning the class to possible attendances through SIP messages, and in accordance with orders from the classroom management system.

Classroom management system is mainly achieved by three functional modules, including classroom management server, classroom web server and classroom management agent. Classroom management agent is an intermediary for realizing communication between Focus and classroom management server. It major function is to realize the interaction between classroom management server and Focus, as well as between classroom management system and classroom control system.

The interaction between classroom attendances and classroom management server has adopted the Browser/Server mode, i.e. to access the classroom web server through a browser. When classroom web server has received the request from classroom attendances, web-based classroom management and class information query will then be achieved.

3.3 Classroom Control System

Classroom control system is the main body of the entire SIP distance education system. All signaling control will be completed by classroom control system. When a class is under progress, the classroom control system would acquire management parameters from the classroom management server to accept and respond to the requests from clients, as well as to control operations related with the media server.

Classroom control system is mainly comprised by three functional modules, including Focus, SIP Stack and Transport Layer . Classroom control system is to be oriented by SIP signaling, and it is an advanced application of SIP user agent, as well as a kernel and essential component in the entire distance education system. It is design to intensively process the signaling interactions among multiple points in the classroom, as well as to control over the progress of class. With service provided by SIP protocol stack, it can realize the SIP signaling communication among SIP classroom terminals. Drawing support from Focus, it can control media server in receiving and redirecting multimedia streams. Through the transport layer, it can receive and redirect SIP messages and multimedia data streams. Besides, it also supports UDP multi-cast and single-cast. One classroom control server can only be used to administrate one classroom. Therefore, classrooms will be identified with unique SIP URLs in SIP servers.

As SIP does not support classroom management and control in itself, we'll need a classroom control protocol to administrate and control classrooms. Classroom management protocol is comprised by a series of classroom control messages. Classroom control messages comply with SIP message form, such as REGISTER, INVITE, BYE, ACK, MESSAGE, NOTIFY, SUBSCRIBE, REFER; Provisional Response (1XX), Final Response (2XX, 3XX, 4XX, 5XX, 6XX). Here, SIP message is the major classroom control message, and has basically realized classroom control functions. In distance education, teachers would ask students to speak, so as to realize an interaction between students and teachers. This is a relatively typical classroom control message. In the following, we have listed the message body for realizing the aforementioned functions [4].

The SIP message body of Teacher: Wangyujiao's requesting Student: Linhaiyun to speak:

REFER sip: Wangyujiao @10.203.2.203 SIP/2.0

Via:SIP/2.0/UDP 10.203.2.203:5060; branch=a7eK6cGc743821ba224cba

From: sip: Wangyujiao@10.203.2.203

To: sip: Linhaiyun@10.203.2.202
CSEQ: 1 REFER
Call-ID:4725e31d5ea8cb7c1978c@10.203.2.203
Refer-To:sip:Conf-ID@10.203.2.203

When Student: Linhaiyun has received the request from Teacher: Wangyujiao, he/she will then send INVITE message to the Classroom Control Server FOCUS, requesting to join in the classroom speech (Linhaiyun → FOCUS):

INVITE sip:Conf-ID@10.203.2.203
Via:SIP/2.0/UDP 10.203.2.202:5060; branch=a8eK3cG5e842a46de
From: sip: Linhaiyun @10.203.2.202
To:sip:Conf-ID@10.203.2.203
CSEQ: 1 INVITE
Call-ID:2cfea2bd76890a597c839@10.203.2.203
Referred-By: sip: Wangyujiao@10.203.2.202

3.4 SIP Server

SIP server mainly provides functions in SIP terminal registration, session management, establishing SIP-based communication mechanism for the entire system, and assisting the education controller to create and maintain SIP sessions between teachers and students in the classroom. SIP server is comprised by three functional entities, including SIP register server, SIP proxy server and SIP redirect server, as is see Fig 1.SIP register server is designed to register users' address; SIP proxy server is used to route and redirect SIP messages; SIP redirect server is in responsible for feeding back proxy address information of target SIP users.

4. Conclusion

With the fast development of multimedia technology and network communication technology, SIP is bound to become the most important multimedia session control protocol in the next generation network. With simple, flexible, extensible, and realizable features, SIP protocol can easily meet the demands of multimedia session in modern distance education, setting interactions between learners and teachers free from spatial restrictions. The technology can greatly improve learners' efficiency, providing new opportunities for the development of distance education in China.

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